AIR MONITORING TECHNOLOGY & METHODOLOGY EXPERT PANEL REPORT & FINDINGS

Convened by

Bay Area Air Quality Management District

July 11, 2013

Acknowledgements –

The Bay Area Air Quality Management District (Air District) wishes to thank both Eric Fujita and David Campbell of the Desert Research Institute (DRI) for their work compiling the *Review of Current Air Monitoring Capabilities near Refineries in the San Francisco Bay Area*. In addition, the Air District wishes to thank members of the Expert Panel listed below for their efforts and time providing input towards the goal of enhancing monitoring efforts at and near Bay Area refineries.

- *George Allen* –Senior Scientist at Northeast States for Coordinated Air Use Management (NESCAUM)
- *Michael Benjamin, Ph.D.* –Chief of the Monitoring and Laboratory Division at the California Air Resources Board (CARB)
- *Kenneth Stroud* (Serving for Dr. Michael Benjamin) –Chief of the Air Quality Surveillance Branch at CARB
- *Philip Fine, Ph.D.* - Assistant Deputy Executive Officer for Science & Technology Advancement at the South Coast Air Quality Management District (SCAQMD)
- *Andrea Polidori Ph.D.* (Serving for Dr. Fine) - Quality Assurance Manager for Science & Technology Advancement at the SCAQMD
- *Jay Gunkelman* – Member of the public and fence line monitoring expert
- *Robert Harley, Ph.D.* –Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley
- *Thomas Kirchstetter, Ph.D.* - Staff Scientist in the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory and an Adjunct Professor in the Civil and Environmental Engineering Department at the University of California, Berkeley
- *Denny Larson* – Executive Director, Global Community Monitor
- *Gary Mueller* –Principal Air Quality Consultant with the HSE Services, Environmental Sciences Department of Shell Global Solutions (US) Inc.
- *Jay Turner, Ph.D.* - Associate Professor of Energy, Environmental and Chemical Engineering at Washington University in St. Louis
- *Gwen Yoshimura* –Air Monitoring Lead in the Air Quality Analysis Office with the Environmental Protection Agency (EPA), Region 9

Executive Summary

The Bay Area Air Quality Management District (Air District) contracted with the Desert Research Institute (DRI) to compile a report that provided a background on current air monitoring capabilities near Bay Area refineries and assembled a panel of air monitoring experts from around the country to review and comment on the DRI report. The Panel agreed that the report adequately addressed the issues and complexity involved with monitoring air quality around Bay Area refineries, in general. They also agreed that the report provided a good starting point for developing further guidance. However, the Panel noted that the report did not include the operating and maintenance costs for each monitoring option and should simply be used to compare and evaluate each monitoring option. In addition, the report could not include every available and applicable monitoring technology but was intended to be a starting point for discussion of options and as a way to evaluate options. Finally, the scope of the report did not allow for a complete discussion of meteorological measurement or other methodologies that might be utilized to estimate exposures.

The Panel generally agreed that an approach that utilized a combination of fence line, community, and mobile monitoring would be required to adequately define exposures during normal operations and when upsets and incidents occur. The fence line monitoring would be leveraged primarily to identify non-routine emissions during normal operation, while the community monitoring would be utilized to develop spatial gradients of chronic exposures. Mobile monitoring would be used to supplement on-going monitoring during major upsets and incidents and to help develop information on spatial variability.

The Panel also recommended that compounds of interest should be identified based on the monitoring goals with relationships and correlations between compounds of interest developed to minimize costs. While it was recognized that not all compounds of interest need to be measured, volatile organic compounds (VOC) should be the primary, initial focus.

Panel members generally agreed that information should be provided to the community through a well-designed website that provides appropriate context and allows more sophisticated users to access more complex and complete data. However, alternate methodologies should also be developed to inform members of the public who lack computer access or need additional information. In addition, a means for the public to provide their observations and experiences should be included and that they should be informed of actions taken in response to observations to build trust.

Data quality and time resolution were major topics of discussion, with Panel members again suggesting that different approaches be utilized for different monitoring goals. For example, fence line monitoring should employ higher time resolution than community monitoring, but community monitoring time resolutions should be increased during upsets and incidents when acute exposures are of concern.

Since technologies are rapidly evolving, the Panel recommended that regular review of available instrumentation should occur with a methodology to cost-effectively update the in-place network. Lines of open and honest communication should be established between industry, the community and regulators to ensure appropriate value is provided by the developed network.

Background

On August 6, 2012, a substantial fire occurred due to a hydrocarbon leak at a crude oil processing unit at the Chevron Refinery in Richmond, CA. The fire resulted in a large plume of black smoke and visible emissions from a refinery flare. The Contra Costa County Health Department issued a community warning and ordered a shelter-in-place for about five hours in Richmond, San Pablo and North Richmond. Thousands of residents sought medical treatment, with most suffering respiratory and/or eye discomfort.

The August 6, 2012 incident prompted the Bay Area Air Quality Management District (Air District) staff and Board of Directors to identify a series of follow-up actions to enhance the Air District's response to similar incidents (Board of Directors, October 17, 2012). One of these actions was to convene a panel of air monitoring experts (Expert Panel) to recommend technologies, methodologies and tools to enhance community air monitoring capabilities near refineries. Another related follow-up action was the development of a new Air District Petroleum Refining Emissions Tracking rule, which would include a requirement that Bay Area refineries establish and operate fence line and community air monitoring systems consistent with guidelines to be developed by the Air District.

As part of this effort, the Air District contracted with Desert Research Institute (DRI) to compile a report that provides background on current air monitoring capabilities near Bay Area refineries and potential air monitoring technologies, methodologies and tools to:

- Provide air quality information for communities near refineries
- Gather data to evaluate health impacts associated with air quality near refineries
- Track air quality changes and trends over time near refineries

The DRI report reviewed and evaluated measurement approaches and methods for assessing the impacts of refinery emissions on ambient concentrations of criteria and air toxics pollutants in nearby communities. Available data for refinery emissions along with ambient air concentrations were reviewed and compared to established levels for acute and chronic health effects to identify the species that should be considered for air monitoring. Various monitoring options were then associated with the following monitoring objectives: short-term characterization of emission fluxes; long-term continuous fence-line monitoring of plant emission releases to the community; community-scale monitoring with varying time scales to evaluate potential chronic or acute health impacts; and episodic monitoring during upsets and incidents. These objectives were reconciled with available air quality data from existing Air District criteria and air toxics pollutant monitoring programs, and air monitoring (both regulatory and voluntary) by the refineries to identify existing gaps in information or useful supplemental data. Published results from relevant applications of the monitoring approaches were reviewed and the specifications for selectivity, sensitivity, precision, accuracy and costs of commercially-available continuous or semi-continuous monitors, and time-integrated sampling and analysis methods were compared for each target pollutant to determine the positive and negative attributes of each monitoring approach and method. Potential augmentations to existing monitoring in the Bay Area were suggested with scalable options. It was the intent of the Air District to utilize the DRI report to provide the Panel with a starting point of discussion.

DRI Report

The DRI report, Review of Current Air Monitoring Capabilities near Refineries in the San Francisco Bay Area (October 29, 2013 Revision), was designed to provide the expert panel with a starting point for discussion by:

- Evaluating current air monitoring capabilities
- Developing a matrix of additional technologies, methodologies and tools that could be employed to enhance air monitoring capabilities and provide information about emissions from refineries
- Providing costs associated with the technologies, methodologies and tools
- Outlining the potential advantages and disadvantages of each option
- Providing a short description of the process used and how the matrix was developed

The DRI report is available at:
http://www.baaqmd.gov/~/media/Files/Technical%20Services/DRI_Final_Report_061113.ashx

DRI Report Executive Summary

The DRI report provided historical and emissions information from the five Bay Area refineries, which includes Chevron in Richmond, Shell in Martinez, Tesoro in Martinez, Valero in Benicia and Phillips 66 in Rodeo. The refineries account for approximately half of the PM2.5, reactive organic gases (ROG) and NOx and over 90% of the SO2 from stationary sources in the Bay Area. In addition, the report also provided a review of available toxic air contaminant (TAC) information and health risk assessment information and findings. This information could be used to help develop a list of compounds of interest and appropriate sampling methodologies that could be employed near the refineries.

DRI provided a review of current Air District and facility monitoring throughout the Bay Area to determine if and where enhancements could be made. This evaluation included meteorological, individual compound, and special study data as well as incident response capabilities. While DRI concluded that Air District monitoring sites adequately represent pollutant concentrations throughout the Bay Area in general and within approximately a mile or two of the refineries, in particular, they may not be representative of concentrations near fence lines and during upsets when localized conditions and short duration events may not be adequately captured.

Current commercially available instrumentation was investigated and information and options provided. The instrumentation fell into four major categories:

- Emissions flux measurements that attempt to determine actual emissions rates from facilities
- Optical remote sensing that uses a light source to measure compounds that pass through a light beam and that can be used to determine compound concentrations across a distance
- Saturation monitoring that uses many sampling devices that are usually exposed for longer periods of time to determine more detailed spatial variations in specific compound concentrations
- Continuous monitoring that uses a less instrument “dense” network than saturation monitoring to provide better time resolved information.

The report then provides information on commercially available measurement technologies that fall into these general categories. In addition, it provides examples of individual equipment and methodologies that could be utilized. The report also covers potential measurement technologies and methodologies that could be effectively utilized during short duration upsets and incidents.

The report's appendices provide operating procedures that could be utilized to perform saturation monitoring and mobile monitoring that could be employed during short duration events and to help determine spatial variability.

The Expert Panel Members

George Allen – George Allen is a Senior Scientist at NESCAUM (Northeast States for Coordinated Air Use Management), an interagency association of the eight Northeastern States. He received a B.S. in Electrical Engineering from Tufts University in 1974. At NESCAUM, Mr. Allen is responsible for monitoring and exposure assessment activities across a range of wide range of air topics, including regional haze, air toxics, on and off-road diesel, near-road, wood smoke, and continuous aerosol measurement technologies. He is the author or co-author of more than 40 peer-reviewed journal papers on development and evaluation of measurement methods, exposure assessment, and air pollution health effects. Before joining NESCAUM in 2002, Mr. Allen was on the professional staff at the Harvard School of Public Health (HSPH) in Boston for more than 20 years, working on a wide range of EPA and NIH funded air pollution studies. While at HSPH, he developed several patented techniques for real-time aerosol measurements.

Mr. Allen serves as the staff lead for the NESCAUM Monitoring and Assessment Committee. He represents states interests to EPA as a member of the National Association of Clean Air Agencies (NACAA) Monitoring Steering Committee and the chartered EPA Clean Air Science Advisory Committee (CASAC).

Michael Benjamin, Ph.D. – As Chief of the California Air Resources Board's Monitoring and Laboratory Division, Dr. Benjamin oversees a staff of approximately 170 scientists, engineers, and field technicians who operate the statewide ambient air quality monitoring network, provide air monitoring capabilities following emergency air releases, conduct chemical analyses of ambient and vehicle exhaust, certify vapor recovery equipment, and develop regulations to reduce evaporative emissions from the gasoline distribution system and off-highway gasoline-fueled equipment. Dr. Benjamin has served in a variety of staff and management positions developing emissions inventories in support of regulations and air quality planning and more recently overseeing the Board's economic analysis and extramural research programs. Prior to beginning his career at the Air Resources Board, Dr. Benjamin worked for five years conducting oceanographic research at Columbia University's Lamont-Doherty Earth Observatory. Dr. Benjamin received his B.S. in Geology from Beloit College, M.S. in Earth Sciences from Dartmouth College, and Ph.D. in Environmental Science and Engineering from the University of California, Los Angeles.

Kenneth Stroud (Serving for Dr. Michael Benjamin) – Mr. Stroud is Chief of the Air Quality Surveillance Branch at the California Air Resources Board. He oversees regulatory air monitoring at more than forty air monitoring locations statewide and has participated in numerous emergency response and community air monitoring studies over the last 26 years with the ARB. Mr. Stroud holds a Bachelor's degree in Chemistry from Cal Poly, San Luis Obispo.

Dave Campbell – Mr. Campbell is an Associate Research Scientist at the Desert Research Institute, whose current research interests are the characterization and apportionment of gaseous and aerosol pollutants and measuring the influence of mobile source contributions and energy production on photochemical processes and human exposure. Prior to joining DRI he spent 13 years working for the NPS/IMPROVE program, monitoring visibility reducing particles impacting protected federal lands. He received MS degrees in Ecology and Engineering from UC Davis and Rensselaer Polytechnic Institute, respectively, and a BS in chemistry from the State University of NY.

Philip Fine, Ph.D. - Dr. Philip Fine is the Assistant Deputy Executive Officer for Science & Technology Advancement at the SCAQMD (South Coast Air Quality Management District). Dr. Fine oversees the SCAQMD ambient network of over 35 air monitoring stations, the SCAQMD laboratory, and numerous special air monitoring projects focusing on air toxics and the local impacts of air pollution. His previous responsibilities at the SCAQMD have included developing the Air Quality Management Plan, strategies for particulate matter control, climate and energy, meteorology and forecasting, air quality evaluation, emissions reporting, and air toxics risk assessment. Dr. Fine serves as SCAQMD's member for the California Air Resources Board legislatively mandated Research Screening Committee. Prior to joining the SCAQMD, Dr. Fine was a Research Assistant Professor at the University of Southern California, Los Angeles where he taught courses and conducted extensive research on particulate pollution and its health effects, resulting in over 45 peer-reviewed scientific publications. Dr. Fine received his Ph.D. from California Institute of Technology in Environmental Engineering Science, and his bachelor's degree in Mechanical Engineering and Materials Science & Engineering from the University of California, Berkeley.

Andrea Polidori Ph.D. (Serving for Dr. Fine) - Dr. Andrea Polidori is the Quality Assurance Manager for Science & Technology Advancement at the SCAQMD (South Coast Air Quality Management District) and is responsible for the development and implementation of quality assurance control methods, plans, procedures, and programs. He is also involved in the analysis of data collected from numerous field activities and air monitoring projects. Prior to joining the SCAQMD, he was a Research Assistant Professor at the University of Southern California (Los Angeles) where he taught courses and conducted extensive research on particulate pollution and its health effects, resulting in over 30 peer-reviewed scientific publications. He received his Ph.D. in Environmental Sciences from Rutgers University (New Brunswick, NJ) and his bachelor's degree, also in Environmental Sciences, from Urbino University (Urbino, Italy).

Jay Gunkelman – Mr. Gunkelman, Quantitative Electroencephalography (QEEG) Diplomate, has served as president of The International Society for Neurofeedback and Research, as well as a board member and treasurer of the Association for Applied Psychophysiology and Biofeedback and is a past-president of the Biofeedback Society of California. Mr. Gunkelman was the first EEG technologist to be certified in QEEG (1996) and was granted Diplomate status in 2002. He co-authored the textbook on EEG artifacting (2001) and has conducted, published or participated in hundreds of research papers, articles, books and international meetings. Mr. Gunkelman is co-founder and Chief Science Officer of Brain Science International and is a popular lecturer at neuroscience meetings worldwide. For the purposes of the BAAQMD panel, Mr. Gunkelman's involvement is related to his community work designing the oldest continuously operated remote sensing fence line system, with internet community reporting, monitoring the Phillips 66 facility between Rodeo and Crockett, CA. This includes FTIR, UV, TDLS and point source monitoring, as well as meteorological data, all with internet tracking. These system's QA/QC documents and on-line efficiency standards as well as community access are relevant to the interests to the panel.

Robert Harley, Ph.D. – Dr. Harley is a Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley, where he has been on the faculty since 1993. He holds a bachelor's degree in Engineering Science (Chemical Engineering option) from the University of Toronto, and both M.S. and Ph.D. in Environmental Engineering Science from the California Institute of Technology. Dr. Harley's research focuses on air quality and sustainable transportation; he is an author of over 80 papers published in peer-reviewed scientific journals.

Thomas Kirchstetter, Ph.D. - Dr. Kirchstetter is a Staff Scientist in the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory and an Adjunct Professor in the Civil and Environmental Engineering Department at the University of California, Berkeley. His research focuses on air quality and climate-related implications of particulate matter, including emission trends and evaluation of emission controls. He has authored or co-authored over 50 publications on these topics and serves as an editor for the Aerosol Science & Technology Journal and the Journal of Atmospheric Chemistry and Physics. Dr. Kirchstetter holds a B.S. in atmospheric science and mathematics from the State University of New York, Albany and an M.S. and a Ph.D. in environmental engineering from UC Berkeley.

Denny Larson – Mr. Larson has nearly 30 years of experience as a community organizer and campaigner working with industrial communities fighting for justice. He developed the first national network in the U.S. focused on oil refineries and the corporations that own them as well as innovating the Bucket Brigade community air sampling system. In his work, he has assisted communities in 27 countries and 100 partner groups establish their own air monitoring network. Mr. Larson has published a series of community organizing handbooks and co-authored a variety of environmental legislation and regulation pertaining to air pollution, accident prevention and environmental monitoring policies at the local, regional, state, national and international level. His work as paid off, as he's negotiated two dozen binding agreements with major polluters in conjunction with impacted communities to reduce tons of unnecessary pollution and create direct community oversight.

Gary Mueller – Mr. Mueller is a Principal Air Quality Consultant with the HSE Services, Environmental Sciences Department of Shell Global Solutions (US) Inc. He has a Master's Degree in Environmental Engineering from the University of Missouri-Columbia, and has worked for Shell in a variety of environmental positions for over 32 years. His experience includes work in water and wastewater treatment, groundwater treatment, and the past 15 years in air quality management programs. His job assignments have included both environmental research and technical support to operations. One of his responsibilities within Shell Global Solutions is to insure the development and maintenance of a skill pool that has the necessary tools and competencies to assess and evaluate the impact of air emissions from Shell and other 3rd party customers' operations on the environment and to mitigate any such impacts. During his career at Shell, Mr. Mueller has authored or coauthored over 20 technical papers and presentations on a variety of environmental topics.

Jay Turner, Ph.D. - Dr. Turner is an Associate Professor of Energy, Environmental and Chemical Engineering at Washington University in St. Louis. His research primarily focuses on air quality characterization and control with emphasis on field measurements and data analysis to support a variety of applications in the atmospheric science, regulation and policy, and health studies arenas. Current research projects include estimating lead (Pb) emissions from piston engine aircraft, high time resolution air toxics metals measurements, and long-term fence line monitoring for gaseous air toxics and particulate matter species at an industrial facility. Dr. Turner currently serves on the Ambient Monitoring and Methods Subcommittee (AMMS) of CASAC, the Independent Technical Advisory Committee of the Texas Air Quality Research Program, and the Health Effects Institute (HEI) project panel for the National Particle Components Toxicity Initiative. Dr. Turner holds B.S. and M.S. degrees from UCLA (1987) and a D.Sc. from Washington University (1993), all in Chemical Engineering.

Gwen Yoshimura – Ms. Yoshimura is an air monitoring specialist in the Air Quality Analysis Office with the Environmental Protection Agency (EPA), Region 9, specializing in ambient air monitoring of lead and sulfur dioxide. She previously worked on air planning issues, focusing on lead and air toxics, in EPA's Region 7 office. Ms. Yoshimura has a B.S. in Earth Systems from Stanford University.

The Expert Panel and Comments on the DRI Report

The Air District sought input from experts in the air monitoring field assembled from throughout the nation. Their knowledge and expertise regarding available technologies, methodologies and tools to enhance air monitoring around refineries will assist the Air District in developing improved air monitoring systems at and around refineries. The entire meeting was webcast and is available here: http://baaqmd.granicus.com/MediaPlayer.php?publish_id=052ef9b8-3bd9-1031-92de-7c92654424e8. This input will be used by the Air District to: (1) further evaluate its current air monitoring capabilities, and; (2) develop additional requirements for community monitoring by the Bay Area refineries as part of the Air District's proposed Petroleum Refining Emissions Tracking Rule (Draft Rule and Workshop Report available here: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/Workshops/2013/1215_dr_rpt032113.ashx?la=en).

The Panel provided feedback and comments regarding the DRI report during the meeting and these comments are summarized below. The DRI report was intended to be used as a starting point for discussion about the appropriate technologies, methodologies and tools to consider. The Panel's input, along with the responses by the DRI co-author, David Campbell will be used to develop a path forward for monitoring at and around Bay Area refineries.

In general, the Panel and David Campbell discussed and agreed that pricing included in the report may not accurately represent all costs associated with the equipment presented in the report. The information presented was designed to provide a general idea of costs, since many aspects would depend on unique variables to each application. In addition, there was recognition that it would not be possible to include all current technologies and equipment available in the report. Members were encouraged to provide specific examples of equipment that they believed may be useful in applications for fence line, community and incident response monitoring. There was also general agreement that meteorology technologies and alternative measurement techniques may not have been fully addressed in the report, but were generally addressed later in the Panel's discussions.

Individual Panel members also noted that specific quality control/quality assurance (QC/QA) issues were difficult to address in the report without first knowing all the compounds to be measured and the number and type of devices to be used. In addition, siting issues were difficult to address given the highly localized specifics required to deal with various siting issues. In most instances, these issues were later addressed in comments from the Panel in response to the questions posed to the panel (charge questions).

Individual Panel members also suggested that the Chevron incident, as well as other refinery incidents, could have been summarized and retrospectives developed, and that other methods of determining exposures, such as continuous emission monitoring (CEM) and modeling, could be discussed in the report and should be considered for future consideration. There was also some discussion that Health Risk Assessments (HRAs) used in the report did not incorporate the most recent data and methodologies necessary to be applicable to current conditions. One member also suggested that the report should be summarized and made available with content directed at the general public and utilizing appropriate context so that it could be easily understood.

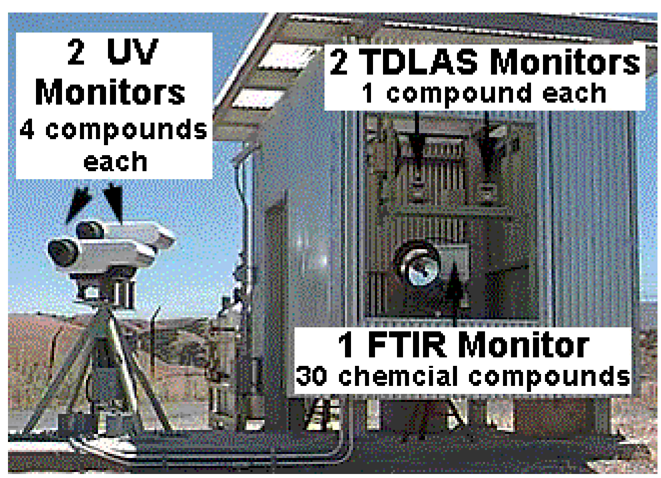
The public was also given an opportunity to comment, and one commenter noted that meteorology technologies were not adequately addressed in the report and that methods of providing information to the public did not adequately address how information might be given context.

A summary of statements made by individual Panel members, and the responses from DRI representative David Campbell, are provided below to provide more information and specifics on the issues discussed. As stated previously, the intent of the DRI report was to foster a conversation among the Panel members so that a more complete and thorough picture of possible monitoring activities could be garnered given the level of expertise and knowledge assembled

Denny Larson - Mr. Larson believed that the costs provided in the report did not represent a hardship to industry given the potential to emit and that typical annual average wind roses should not be used to site community and fence line monitoring since there are large short duration meteorological variations not captured by these annual averages. He also commented that operating culture at refineries was not addressed, that monitoring activities could be a good first step to changing operating culture, and that current and future increased housing density around refineries should be discussed.

Response from David Campbell – Mr. Campbell provided context for the cost information and stated that expected costs of fence line monitoring compared to traditional monitoring are expected to be high. He also pointed out that meteorological measurements used were from the refineries themselves and were not at the elevation of the stacks, so may not be representative of winds at elevation and that modeling would utilize much higher time resolved meteorological data. Mr. Campbell agreed with Mr. Larson regarding the potential that well informed monitoring may have the desired effect of eliciting proactive action on the part of refineries and cause a change in operating culture.

Gary Mueller – Mr. Mueller pointed out that monitoring system design, infrastructure improvement, equipment operating and maintenance and other costs were not included in the report and would be difficult to accurately quantify in a general way. He also believed that inventory emissions, especially for particulate matter (PM) may not be representative, especially given that Bay Area plants are gas fired. As a result, the compounds measured need to be correctly prioritized.



Response from David Campbell – Mr. Campbell agreed that the majority of cost information was associated with capital costs and did not include installation and operational costs, as these costs are specific to the facility and difficult to estimate. He also agreed that HRA and emissions estimates should be updated and validated.

Ken Stroud – Mr. Stroud believed that the report should contain a retrospective of the Chevron incident and that continuous emission monitoring (CEM) and source test emission calculations could be used in modeling to estimate exposure.

Response from Air District staff and Denny Larson – Staff and Mr. Larson discussed the various methods used to characterize the Chevron incident. Staff also stated that CEMs located throughout the refineries could be used in various ways to provide information to the public.

Jay Turner – Professor Turner, pointed out the complexity of emissions associated with Bay Area refineries, believed a discussion of the health risk assessment (HRA) should be included to address changes in methodologies that have occurred over time and potential errors inherent in the HRA process.

Response from David Campbell – Mr. Campbell stated that the HRAs were the latest available. He also pointed out that fugitive emissions, which are extremely difficult to quantify, would greatly affect the compound profiles from each refinery and, hence, the type of monitoring needed.

Jay Gunkelman – Mr. Gunkelman believed that while the cost estimate may not include everything, the refineries ability to pay should be included if cost estimates are revised upward. He also pointed out that long-term data from fence line monitoring is available online, though it may be available on other websites. He believed more traditional point source monitoring locations, such as Ground Level Monitors (GLMs), are important to have as a backup to fence line monitoring and that was not addressed in the report. He stated the importance of including both upwind and downwind measurements and provided examples at various Bay Area refineries to illustrate this point. He also believed it important to include a discussion of path length distance associated with open path measurement systems.

Response from David Campbell – Mr. Campbell agreed that upwind and downwind monitors are critical, though with the complex topography and meteorology in the Bay Area, this can be a difficult task to accomplish. He also mentioned the need for highly trained staff to accomplish the majority of measurements discussed.

George Allen – Mr. Allen pointed out that the report may not have addressed the issues associated with appropriate quality control screening as real-time data are made available to the public.

He believed that many alternative methodologies were not addressed in the report and should be considered, examples provided included:

Flux estimate monitoring (open path monitoring with a vertical component in addition to the horizontal component); adequate meteorological monitoring, including measurements at various elevations; video monitoring; seven-wavelength Aethalometers; total sulfur; short term PM measurement; Condensation Particulate Counter (CPC); ThermoScientific PDR and/or ADR 1500, and; SynSpec Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX). He pointed out that equipment and operational costs have been lowered significantly over time and that there are now many sensors available at low cost, though he could not vouch for the accuracy of these instruments.

In addition, he believed that the following issues involving identified methodologies may not have been adequately addressed:

Uptime of Open Path; the costs and benefits of saturation/community scale monitoring; cheaper "do-it-yourself" measurements being investigated by EPA's Office or Research and Development (ORD). He also cautioned that emissions inventory estimates, especially older ones, tended to underestimate actual emissions, especially those associated with fugitive sources.

Response from David Campbell – Mr. Campbell noted that continuous PM measurements were not covered in-depth in the report and that composition would be needed to determine source. He agreed in general with Mr. Allen's recommendations for particular instrumentation not included in the report.

Gwen Yoshimura – Ms. Yoshimura suggested that the benefits of identifying specific compounds (tracers) associated with refinery operations and performing tracer studies to aid in modeling and equipment location could be included.

Response from David Campbell – Mr. Campbell pointed out that there are no really well defined tracers associated with the particular individual refineries.

Robert Harley – Professor Harley noted that decreasing concentrations of benzene and associated compounds were likely caused by better mobile source controls, that measuring organic compounds other than BTEX is useful, that higher time resolution for PM measurement was important, that odor and smoke on both a chronic and acute scale were critical to consider and he endorsed using flux estimate monitoring at each refinery.

Andrea Polidori – Dr. Polidori suggested that an Executive Summary of the report be produced for the community and noted that a study of flux estimate monitoring was being performed near a Southern California refinery by UCLA. He also suggested that a combination of monitoring techniques could be employed to provide better overall monitoring, such as using total hydrocarbon measurement to trigger canister sampling for laboratory analysis if measurements exceeded a predetermined level, and methods such as this were not addressed in the report.

Response from David Campbell – Mr. Campbell stated that the report contained only commercially available technologies.

Members of the public – Members of the public believed that human monitoring should be addressed in the report, providing a more holistic approach, that data be presented in a way that the public could understand, that meteorological monitoring in four dimensions be addressed for both fixed and mobile equipment, that trajectory modeling capabilities be addressed, that exposure information be provided, that other agencies be included and that satellite evaluation be considered in the report.

Response from David Campbell – Mr. Campbell provided information requested in email for saturation monitoring which were contained in the report.

Gary Mueller – Mr. Mueller pointed out that there are major differences in flux measurements versus direct concentration measurements and, therefore, there are potentially large, unqualified errors that may be associated with flux emissions estimates, particularly regarding the meteorological components. He also stressed that it is important to concentrate on what measurements are of value to both the community and industry, and that overall monitoring goals need to be well defined.

The Expert Panel Addresses Charge Questions

The charge questions the Air District developed for the Panel to consider and member comments are presented below. These comments and input provide a wide range of ideas to consider along with those developed in the DRI report. The Air District intends to use this input to develop guidance for air monitoring activities at Bay Area refineries.

The charge questions considered were:

- *What should the size and spatial orientation of a network of monitors be around refineries*
- *What network components should be considered (compounds measured, technology and instrumentation used, methodologies applied, air quality assessment tools utilized, etc.)*
- *How should the data be provided to the public*
- *What should be considered when developing measurement quality objectives, such as:*
    - *What type of instrument siting criteria should be used*
    - *What should the time resolution of the equipment be*
    - *How often should the instrumentation be calibrated*
    - *What should the accuracy/precision/completeness requirements of the data be*
    - *What other quality control/quality assurance requirements should be put in place*
- *What technologies, methodologies and tools could be employed to augment any fixed network to better quantify pollutant variations over space and time, especially during short duration incidents*
- *What emerging technologies might be utilized in the future to further enhance community air monitoring capabilities*

Summary of Comments

In general, the Panel agreed that a combination of measurements would be required to adequately provide the public with information regarding emissions from refineries in the Bay Area. Members generally agreed that fence line monitoring, particularly open path monitoring that provided information along refinery boundaries, was useful. However, these systems did not provide information about actual community exposures and concentration gradients as distance from fence lines increased. Therefore, monitoring within the community was necessary to capture this information. Members generally agreed that this community monitoring would require a flexible approach with a combination of traditional, fixed-site regulatory air monitoring and more dense, lower cost methods that would allow for better spatial coverage. This coverage should utilize a “layered” gradient approach that focused on near source measurement to help define concentration gradients. During incidents and upsets, it was recognized that a fixed network would likely not adequately characterize localized and highly variable exposures and that mobile monitoring would be the best methodology to capture these emissions. There was also discussion of the usefulness of emission flux measurements to determine the accuracy and variability of emissions inventories. Most Panel members agreed that the DRI report provided appropriate information on the various general techniques available with the appropriate goals and strategies identified in both the report and presentation provided.

The Panel also discussed and generally agreed that compounds of interest should be identified and investigated with relationships and correlations developed to better identify appropriate monitoring goals. It was also generally recognized that not all compounds of interest should be measured, that volatile organic compounds (VOC) should be the primary focus, and that every in-place, available resource should be utilized and/or leveraged to provide information to the public, such as the existing air monitoring network, CEMs and HRAs.

The Panel generally agreed that the data collected should be provided to the public through an easily understood web interface with appropriate context provided. However, alternate methodologies should also be developed to inform members of the public who lack computer access or need additional information. The context should include ways for the public to compare measurements to other locations and to appropriate health indicators and to recognize when values were below instrumentation's level of detection. In addition, there should be ways for more sophisticated users to access and download more complex and/or historical data. Most members of the Panel indicated that the website should employ ways for the public to provide information back to industry and the Air District regarding their experiences and observations. There was much discussion about how to address data quality and the removal/notation of data that did not meet desired quality bench marks. Most members agreed that data completeness was critical, with some members of the Panel representing the community being less concerned about issues arising from data quality.

The Panel generally agreed that higher time resolution was desirable, with the recognition that time resolution and accuracy needed to be appropriately balanced. It was also generally agreed that time resolution depended upon the monitoring goal associated with the measurement and that some flexibility should be developed to address this issue. For example, fence line monitoring should have a higher time resolution, on the order of five minutes, while community monitoring of chronic exposures could have times on the order of hourly, or daily, depending on the monitoring need. However, during incidents or upsets, the community monitoring time resolution should be increased to represent more acute exposures and mobile monitoring should have the highest time resolution possible to address acute exposures and spatial variability. Most Panel members believed the Air District along with instrument manufacturer recommendations would be adequate to determine additional data quality issues.

Members of the Panel generally agreed that periodic review of applicable technologies would be required to ensure that the best techniques were utilized. In addition, Panel members agreed that lines of communication should be fostered to ensure transparency and trust.

- ***What should the size and spatial orientation of a network of monitors be around refineries***

Participants agreed that fence line monitoring in addition to community monitoring be employed. Fence line monitoring should cover the majority of refinery/community interface as possible. They provided the following comments on the community monitoring portion.

Jay Turner – Professor Turner stressed that the appropriate size and spatial orientation of any monitoring network depends on many variables; especially the desired compounds being measured, their relationship to emissions from the refinery and the changes in concentration with increased distance from the source. For example, he noted that particular point sources, such as delayed cokers and catalytic crackers would require a very focused monitoring approach if metals were the targeted compounds, while focusing on hydrocarbons would require a very different approach.

George Allen – Mr. Allen suggested that a "layered" approached should be utilized in which gradients are measured based on a limited number of fixed sites with accurate, stable and continuously operated instrumentation followed by "layers" of more spatially dense measurements that provided better spatial coverage designed to provide more information, potentially sacrificing accuracy or other measurement characteristics to lower costs based on the overall monitoring goal. Panelist's widely agreed that this was a desirable approach.

Jay Gunkelman – Mr. Gunkelman stressed that each refinery be evaluated separately since each facility has unique characteristics.

Gary Mueller – Mr. Mueller stated that the current air monitoring network for NOx, PM and SO_2 probably does an adequate job. For VOC's, there is likely room for improvement. So while there are many compounds that may be impacting the community, the focus should be on those that are more known and likely to have impacts, while other, less obvious compounds potentially being the focus of limited investigations prior to a more widely deployed network.

Denny Larson – Mr. Larson agreed with the above approaches and stressed that community involvement would be a good starting point to base investigations of less obvious compounds on, focusing on symptomatic and odor log observations by the community. The involvement of the community in the process should be ongoing to capture changes in refining processes over time.

Robert Harley – Professor Harley stressed that visual and olfactory information collected by the community was important and need not involve expensive equipment or large amounts of technology to accomplish.

Jay Turner – Professor Turner stressed the importance of identifying gradients by measuring in areas that had not been included in the past and relating those measurements back to longer term measurements in the area, providing an idea of scale of impacts and context to measurements. He pointed out that measuring close enough to the sources with appropriate spacing between measurements to fully capture gradients was the key (capturing the "zone of influence"). He also stressed that a representative background site near the refineries was critical to understanding localized concentrations since emissions from refineries mimicked mobile sources in many, surprising ways. He also believed that a gradient/saturation or "layered" approach was appropriate.

Ken Stroud – Mr. Stroud agreed with Professor Turner that a gradient, saturation approach as described by the DRI report was best.

Andrea Polidori – Dr. Polidori stated that budgets need to be defined up front to ensure that adequate sampling is performed prior to funding being exhausted. He also stated that time resolution and capture of seasonal variation was the biggest obstacle to overcome with a gradient approach.

Gwen Yoshimura – Ms. Yoshimura agreed with the above approaches and that a combination of all of the above methods should be employed.

Jay Turner – Professor Turner believed that saturation monitoring could inform the location of more permanent sites and that those site should be located quite near the facilities (within blocks). He believed that no more than three permanent sites should be considered with one of those sites being a "background" site.

Thomas Kirchstetter – Dr. Kirchstetter cautioned that shorter duration monitoring could be problematic due to seasonal variations in meteorology and that these factors must be considered when shorter term studies are developed.

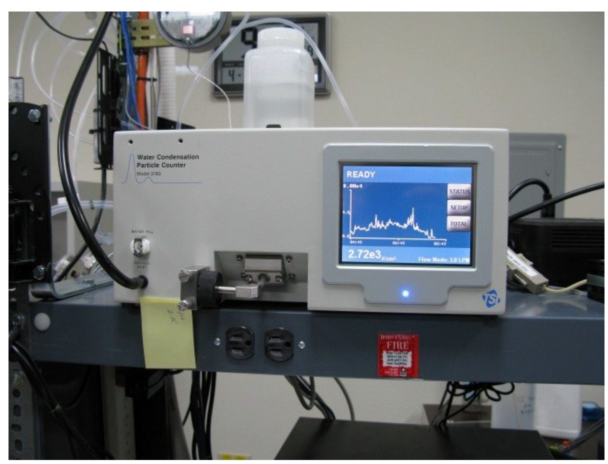
- ***What network components should be considered (compounds measured, technology and instrumentation used, methodologies applied, air quality assessment tools utilized, etc.)***

Jay Turner – Professor Turner stressed that VOC's are the logical starting point for any study and refinery-to-refinery variation should be identified, if possible. Once VOC relationships and correlations are developed, limiting the number of compounds measured would be a good way to limit costs. He also believed that use of real-time instrumentation was best suited to identify correlations and unique variations. He stressed that speciation of hydrocarbons (such as what field gas chromatographs/SynSpec-like equipment would supply) are well suited for these purposes.

George Allen – Mr. Allen agreed that VOC's should be included and limited to identified "indicators", but also believed sulfur compounds should be used as indicators, especially since most open path equipment respond well to these compounds. He also identified formaldehyde as an example of a risk driver that should be measured, but that it is extremely difficult to measure well. He felt that passive sampling for VOC's, such as canisters, should be triggered by total non-methane hydrocarbon (TNMHC) measurements. He identified ammonia as a compound that is easily measured using passive technologies, but difficult to measure continuously. He used these examples to demonstrate the complexity and difficulty in designing community monitoring networks and the need for a flexible approach.

Gary Mueller – Mr. Mueller pointed out that PM measurements at natural gas fired refineries are not effective during normal operation due to the low amount of PM directly emitted. Measurements of NOx and SOx are performed largely at emission points and probably do not need to be addressed offsite. Identifying the monitoring goal and identifying the impacted areas not addressed by historical monitoring is the first place to start.

Jay Gunkelman – Mr. Gunkelman stressed that upwind and downwind measurements were critical and that specifics and uniqueness of site locations were important to consider, especially during divergent seasons. He believed 10-meter meteorological towers provided the most representative information. He also believed that limiting the number of compounds to include only the most important was necessary, but that at least one compound (for example, carbon tetrachloride) should be used to serve as a background QA/QC check.



Robert Harley – Professor Harley supported the use of radar profilers for meteorological measurements and also believed that flux estimate monitoring was ideal to validate emissions inventory estimates, providing a more realistic estimated community concentration and an ideal starting point for identifying community monitoring needs. He also reminded everyone that PM measurements while potentially not an issue during normal operation, was important during upsets and incidents.

George Allen – Mr. Allen believed that sodar was a good methodology to employ to estimate mixing heights. He also added that if methane and TNMHC measurements were made, that the methane measurements would be a good QA/QC check of the TNMHC data.

Denny Larson – Mr. Larson believed that PM should be included in any network design and that polycyclic organic hydrocarbon compounds (PAHs) should also be considered in the event of fallout from upsets and incidents. He also believed measurements at elevation should be considered to capture buoyant emissions. Mr. Larson also believed analysis of past incidents and upsets were critical to inform future actions.

Jay Turner – Professor Turner stressed again that identification of compound relationships and correlations in conjunction with potential facility uniqueness should be the starting point for VOC measurement. He also agreed that carbonyl measurement is desired, but difficult, and supported the use of UV DOAS instrumentation based on its potential ability to measure carbonyls.

Gwen Yoshimura – Ms. Yoshimura noted that a Beta Attenuation Monitor (BAM) is now in place at the San Pablo air monitoring station as well as other Bay Area locations and these instruments are now producing hourly PM data. She also stated that data quality and presentation to the community must be considered along with everything else.

- ***How should the data be provided to the public***

Denny Larson – Mr. Larson stated that all available air quality data the Air District is responsible for should be provided along with context and a feedback mechanism. He believed that the fence line monitoring systems at Crockett and Rodeo are good models. He also reminded that there are methods other than the internet to provide the information to the public.

Jay Gunkelman – Mr. Gunkelman stressed that feedback to public input must be instantaneous and thorough and that the GLM data need to be posted online. Website graphical interfaces need to be simple and provide general information that is easily understood.

George Allen – Mr. Allen pointed out that data should be web-based along with an alternative, such as a telephone hotline, for those without computers. The web-based data should be “layered”, so that people with rudimentary knowledge have a page and that people who wish more complex data, such as researchers, can get more complex data. He noted that there is a great deal of meteorological data available through other sites, such as Weather Underground. Data should also be tied to risk and/or exposures.

Jay Turner – Professor Turner suggested that context be provided with a baseline reference (either regulatory or “normal” concentration) with comparisons to other Air District/State sites. He stated that AirNow is a good model.

Gwen Yoshimura – Ms. Yoshimura suggested that a feedback loop be developed between the refineries and community so that there are defined actions taken when certain concentrations are reached. These levels and actions should be communicated so that the public knows that there are actions associated with the data. She supported the multilevel approach and reminded that download speeds should be considered.

Ken Stroud – Mr. Stroud suggested that data also be shared with websites that display national data, such as AirNow, and state sites, such as AQMIS, so that the public can get everything they need at one location.

Andrea Polidori – Dr. Polidori suggested that there be consideration for allowing a time period between when the data are collected and when they are displayed to the public to allow for appropriate quality assurance (QA) activities to be completed, if necessary. He provided the example of laboratory analysis that would require additional time. He also suggested that there be a tie-in between measurements and health consequences, if possible, potentially utilizing real time health measurements (though that may not be quite ready yet).

George Allen – Mr. Allen stated that he believed missing data had the potential to raise trust issues and that transparency was the answer to these issues. A mechanism to explain why data are missing should be provided, such as meta data and performance parameters outside of which data are not valid. In addition, clearly identifying what is displayed when values are below the instruments limit of detection (LOD) is important.

Gary Mueller – Mr. Mueller suggested that all data be displayed and labeled to indicate potential issues with data quality, though he was not sure how that might be accomplished.

Denny Larson – Mr. Larson stated that data quality is not an issue as long as real-time results are displayed and available, with QA activities and data reporting that requires additional time achieved quickly. He believed that reliability and up-time were the more critical issues and that 99% data completeness should be the goal. Any corrective action should be taken quickly and feedback mechanisms, such as blogs and bulletin boards, should be employed to provide a venue for sharing information and suggesting improvements.

Thomas Kirchstetter – Dr. Kirchstetter pointed out that web pages should initially provide straightforward information with the ability to get additional, more complex data built in. He believed that the current Air District website was a good starting point, but that it needed to be improved. Having the ability to plot data in graphical format would potentially enhance understanding. Dr. Kirchstetter also believed that displaying data with the correct level of precision was important and that using “<LOD” when concentrations were below instrumentations LOD would be the best method as long as LODs were provided.

Jay Gunkelman – Mr. Gunkelman agreed with Mr. Larson that removal of data that didn't meet quality assurance requirements was not an issue as long as high rates of data completeness were maintained. He supported the use of "<LOD" for values below detection levels. His main concern was the robustness of the website and the defensibility of the data. Traffic to the website could also be used as a means of measuring whether problematic issues were occurring.

Jay Turner – Professor Turner believed that issues around data quality would be addressed quickly if all refineries are performing similar measurements, the data stream is monitored and feedback around missing data or data outliers are addressed.

George Allen – Mr. Allen stated that urban background numbers should be provided to give context to the concentration numbers and associated risk.

- ***What should be considered when developing measurement quality objectives, such as:***
  - ***What type of instrument siting criteria should be used***
  - ***What should the time resolution of the equipment be***
  - ***How often should the instrumentation be calibrated***
  - ***What should the accuracy/precision/completeness requirements of the data be***
  - ***What other quality control/quality assurance requirements should be put in place***

Denny Larson – Mr. Larson stressed the importance of good siting and that elevation, especially for fence line monitoring, is an important consideration. He also stressed that community monitoring should take place in impacted communities, and that compromises for power and security should be less of a consideration than appropriate location within the community.

Jay Gunkelman – Mr. Gunkelman stressed the need for short time resolution, especially at the fence line (5 minute). He stated that the vendor instrument operational recommendations should drive QA requirements. Data completeness for components and the overall system should be 95%.

Robert Harley – Professor Harley agreed that one hour time resolution is the minimum acceptable time frame. Backup power should also be a serious consideration.

Ken Stroud – Mr. Stroud stated that the Air District should have oversight of the QA processes, which the Air District supports.

Jay Turner – Professor Turner made the point that time resolution could be varied according to the major goal of the monitoring. During upsets, for example, time resolution should be increased. This may result in a decrease in accuracy, but this may be an acceptable trade off during short term events when acute exposures are more important. For more chronic exposures, accuracy becomes more of a driving force and time resolution of an hour is more acceptable.

George Allen – Mr. Allen supported the view expressed by Professor Turner, that time resolution and accuracy should be based on the importance of the exposure (chronic versus acute).

Andrea Polidori – Dr. Polidori stated that it was better, in his opinion, to delay posting of data so that quality was ensured and data would not have to be removed at a later date, potentially causing trust issues. He also stressed that co-location of instrumentation would need to be considered to provide information on overall data quality.

Gwen Yoshimura – Ms. Yoshimura stressed that community involvement was critical and that they should be involved in determining how to balance time resolution and accuracy.

- ***What technologies, methodologies and tools could be employed to augment any fixed network to better quantify pollutant variations over space and time, especially during short duration incidents***

Thomas Kirchstetter – Dr. Kirchstetter thought sampling during incidents could be modified to address the shorter duration of incidents, especially those at permanent locations near facilities. For example, canister samples, which are traditionally collected over 24-hours, could be collected every three hours for 24 hours during the event and used to compare to the more traditional sampling. This would provide flexibility and potential cost savings.

Denny Larson – Mr. Larson was not sure if the technique described by Dr. Kirchstetter should be employed. He believed this to be was more of an issue with the goal of the sites (ambient versus incident related). He suggested that monitoring near facilities should follow a different siting criterion. Siting for incidents should be mobile, as opposed to fixed, as this would be the best way to "track" impacts.

George Allen – Mr. Allen supported mobile monitoring during incidents which would augment the fixed network. Time resolution of a minute, maximum, should be employed with the ability to grab canister samples when direct reading instruments indicate high concentrations. He believed this may also be a situation to employ the semi-quantitative Ecochem PAH instrument (fast response and easy to run). This should be tied to real time meteorology and modeling.

Jay Turner – Professor Turner also agreed that mobile monitoring during incidents is likely the best methodology. Characterization of gradients and specific characteristics of individual facilities would also provide context during mobile monitoring. He supported flux measurements and the inclusion of error analysis associated with these types of measurements. He believed there were many good examples of community monitoring outside of California and it would be very valuable to incorporate the lessons learned from these studies and investigations.

Thomas Kirchstetter – Dr. Kirchstetter also supported the use of mobile monitoring during incidents. He noted that there are limitations to mobile measurements, however. He also advocated for use of mobile monitoring resources for gradient and other special studies.

Gary Mueller – Mr. Mueller also supported mobile measurements during incidents. GPS and highly time resolved measurements can provide large amounts of data. He also noted that technology that could be employed for incident response is rapidly changing.

Ken Stroud – Mr. Stroud pointed out that emission profiles don't always exist for any given incident-based release. He advocated for building emission profiles for potential scenarios.

Denny Larson – Mr. Larson supported mobile monitoring and also supported the use of mobile monitoring to aid in gradient determination during more routine operation of the facilities. He believed the use of mobile monitoring during routine operations could help build trust with the community by providing information on daily operations that impact neighbors. He also supported online reporting during incidents by the community and facilities and provided examples of this type of reporting taking place in Texas.

Jay Gunkelman – Mr. Gunkelman supported the use of backup power for fixed sites since power disruptions can cause major upsets at facilities. He again stressed the need for highly time resolved measurements at the fence line. Portability of instrumentation should also be considered so that instrumentation can be moved if experience indicated it.

- ***What emerging technologies might be utilized in the future to further enhance community air monitoring capabilities***

George Allen – Mr. Allen provided information on EPA's ORD activities that were directed toward emerging technologies and also provided information on cutting edge instrumentation being developed by manufacturers (IRIS from ThermoScientific. This product is currently undergoing improvements by the manufacturer and will be re-introduced under another name).

Denny Larson – Mr. Larson stressed the need for periodic review of in-place and emerging technology and the need to investigate how improvements can be brought into operation. He also stressed that communication between government, the facilities and the community is critical to continue over time.

Gary Mueller – Mr. Mueller pointed out that there are numerous technologies that need to be investigated, tracked and potentially installed, but it is important to consider that any technology needs to be tested and evaluated thoroughly prior to use to inform the community.

Members of the Public – Members of the public stressed that it is important that government agencies respond to complaints so that the community knows that their observations are being recognized and investigated. The data needs to be made understandable to the public and context must be provided to ensure that the effort provides value to the community. The public would like to focus on preventative actions. Online information, such as wikis should be considered. Members of the public supported providing an explanation of why data are invalidated. The public also supported the development and dissemination of emission profile information, the use of video monitoring and the investigation of better manufacturing processes that reduce emissions.

- ***The Panel provides their final thoughts***

Robert Harley – Professor Harley stated that whatever actions are taken, they must provide value to the various stakeholders.

Denny Larson – Mr. Larson pointed out that his principals for air monitoring that were provided to the Panel would be a good starting point for any future discussions.

Jay Turner – Professor Turner stressed that the DRI report provided the appropriate five objectives to consider for additional network development and the emphasis of those objectives will be based on policies developed by the Air District through the various inputs, including the Panel and the community.

Gwen Yoshimura – Ms. Yoshimura reminded that the data can have many uses, including uses for the refineries that should use the data to make improvements to their processes proactively.

Gary Mueller – Mr. Mueller stated that continuing communication between all parties is important and should continue to be developed and supported. He also fully supported the use of mobile monitoring during incidents, especially monitoring of PM.

George Allen – Mr. Allen stated that near-field data was of high value, especially to industry. He noted that there have been improvements, but that tools such as video can be quite valuable to both the community and industry.

Jay Gunkelman – Mr. Gunkelman stressed the value of community/government/industry interaction during any process. He was encouraged that monitoring will be taking place at refineries throughout the Bay Area.

Andrea Polidori – Dr. Polidori agreed that good communication is required for any effort to be successful. He suggested that there are practices in place in the South Coast Air District, such as email notifications of planned and unplanned flaring events that could be incorporated in the Bay Area.

Panelists Response to Comments –

Members of the Panel were given an opportunity to provide clarification to comments attributed to them and were incorporated into this report. Panel members were then given another opportunity to provide comments on the DRI report not captured above, and comment on input from other Panel members. All input is provided below.

Mr. Denny Larson provided comment:

“We need to make clear that the process of doing these tasks should model what is done with the GLM monitoring network. That is the District provides a general outline for installing the network and provides specific recommendations for equipment. Then it is up to the refinery to install and contract out the operation of the equipment.

The Air District needs allow the refineries to make available to the public the GLM data that is currently being generated immediately. It costs nothing and provides an immediate public good. Again the key would be to let the refineries make it public, not the air district.

Have each refinery set up a process by which it makes public its data. This should also include input/feedback and participation from local communities. It's better to provide local input as compared to a process where a central authority makes all decisions.

The fence line monitor success for 20+ years in Rodeo at Conoco is due in large part to the local community working group working with the refinery and the relevant agency. The District's policies and rules in this regard should require a local working group of refinery neighbors.”

Professor Robert Harley provided comment:

My comments “are all mentioned in the draft report already, but I want to emphasize/elaborate on some key points.

1. That solar occultation or similar open-path techniques be used to survey baseline emissions from each refinery under normal operating conditions (this can be used to check the District's emission inventory; there may be uninventoried fugitive sources of VOC emissions especially).

2. That District monitoring efforts relating to abnormal events/upsets at refineries include measurements of ambient particulate matter using online methods that provide at least hourly updates to the data. Such data on PM mass (measured, for example, by beta attenuation) could be useful in identifying smoke plumes that arise due to fires or large flaring events at the refineries. Fence line and community monitoring efforts seem heavily focused on measuring gaseous pollutants.

3. Earthquakes are a known hazard in the Bay area, and both refinery systems and BAAQMD monitoring capabilities should be assessed for safety and resiliency in the face of extended outages in electric power and other lifeline systems (water supply, transportation, communication, natural gas) that may ensue.

4. Enhancements to meteorological data collection (e.g., from one or a few radar wind profilers operating continuously) may help the District assess the transport and magnitude of air pollution plumes from refineries, as well as impacts on nearby communities. Such data may also serve other District needs such as air quality modeling and planning efforts."

Mr. Ken Stroud provided comment:

"I have reviewed the report, *"Air Monitoring Technology and Methodology Expert Panel Report and Findings,"* and find that it adequately captures my input to the Panel Discussion of July 11, 2013."

Dr. Andrea Polidori provided corrections/clarifications to comments attributed to him which have been incorporated into this report and also provided comments on the DRI Report, which will be forward to the author of that report for editing consideration.

Mr. George Allen provided corrections/clarifications to comments attributed to him and have been incorporated into this report.

Panelists Written Comments –

District staff invited Panelists to provide additional written comments after the meeting to address the charge questions and provide additional insight. These are attached, represent the position of the Panelist, and have not been edited by Air District staff.

Response to Charge Questions to the Air Monitoring Technology and Methodology Expert Panel
DRAFT – George Allen July 17, 2013

Q 1: What should the size and spatial orientation of a network of monitors be around refineries

A network of fixed sites should have multiple layers to meet the multiple objectives needed to properly assess source emissions and population exposures both for routine (normal) operating conditions as well as abnormal emission scenarios.

1. Near-field source characterization measurements. This component of the network is designed to measure pollutants at or near the fenceline (up to ~ 100 m away), and potentially at different heights above the ground. Open path methods are most appropriate here, but not necessarily located on or near the ground. Near-field sampling should be located at heights that are relevant to the structure of the refinery and known or likely emission sources). These measurements would ideally be located both up- and down-wind of the refinery (using prevailing wind directions).

2. Mid to neighborhood-scale fixed sites with full instrumentation. These sites would be the backbone of a long-term network with multiple measurements, including both real-time and integrated sampling. These sites would be between 500 to ~2000 m from the fenceline, and provide detailed and high quality data for routine (non-event) conditions that could be used for assessment of chronic health risks. Depending on resources, this could be a single down-wind site or include several down-wind sites and a single up-wind site. These fixed sites should be located at the most likely high-concentration area, determined by dispersion modeling using appropriate on-site wind fields at multiple elevations if possible. One potential routine use of the data from these sites would be to ground-truth refinery emission inventories. These have been shown to sometimes be substantial under-estimates of true facility emissions due to the potential for a large number of unidentified fugitive emission sources. See:

Henry, R.C., Spiegelman, C.H., Collins, J.F., EunSug Park (1997). "Reported emissions of organic gases are not consistent with observations." Proceedings of the National Academy of Sciences of the United States of America, Vol. 94, 6596–6599.
http://www.pnas.org/content/94/13/6596
and
Ryerson, T. B., et al., Effect of petrochemical industrial emissions of reactive alkenes and NOx on tropospheric ozone formation in Houston, Texas. J. Geophys. Res., 108(D8), 4249, doi:10.1029/2002JD003070, 2003. Report at:
http://www.researchgate.net/publication/225089790_Signatures_of_terminal_alkene_oxidation_in_airborne_formaldehyde_measurements_during_TexAQS_2000/file/9fcfd51072f40594aa.pdf

3. Mid to neighborhood-scale fixed sites with limited instrumentation. These sites would be simpler and lower cost, to provide additional spatial information on a limited number of indicator pollutants. Passive or low-cost real-time sensors would be used at these sites. One of these sites should be collocated with a fixed site described in #2 above for QC purposes. One should be up-wind of the refinery.

Q 2: What network components should be considered (compounds measured, technology and instrumentation used, methodologies applied, air quality assessment tools utilized, etc.)

For near-field open path measurements, indicator pollutants are appropriate. These could include methane, benzene or other BTEX VOCs, SO2, or other relevant pollutants. NOx and PM do not need to be measured.

For the larger fixed site monitoring locations (Q1 #2 above), the following measurements should be considered, roughly in order of importance:

Real-time BTEX (Synspec or similar) with 5 to 15-minute resolution

SO2 and total gas-phase sulfur (e.g., reduced S compounds) with 5 to 15-minute resolution

Methane and total non-methane HC with 5 to 15-minute resolution

Optical Black Carbon (BC). The new version of the Magee/TAPI model AE33/633 Aethalometer addresses the limitations of "legacy" Aethalometers, including noisy short-term measurements and "spot-loading" effects. The instrument provides stable data with high time resolution (1-minute or less) over the range of 950 to 370 nm, with 1-minute LOD of ~ 50 ng/m3. Enhanced response at 370 nm relative to 880 or 950 nm is a specific and semi-quantitative indicator of cellulose combustion.

Particle number concentration (PNC or UFP) down to < 10 nm is readily measured with the TSI 3783 CPC (TAPI model 651) with rapid response time and high sensitivity. PNC along with time-resolved and sensitive PM2.5 (pDR-1500) can give an indication of the age of the aerosol; high PNC with relatively low mass is typical of very fresh combustion, while relatively low PNC and high PM2.5 indicates an aged aerosol.

Automated GCs can provide speciated VOCs with high time resolution; these data can be useful to ground-truth total VOC emissions from large facilities as noted in Q1, #2 above).

NH3 (resolution TBD based on method – electro-chemical for higher "event" concentrations ~1 ppm and up)

Meteorology:
10 meter wind with 5 to 15-minute resolution
Ceilometers give a useful measurement of mixing height up to ~ 5 km and are relatively simple and inexpensive compared to radar/profiler systems. Example:
http://www.vaisala.com/en/products/ceilometers/Pages/CL31.aspx

Highly time-resolved (1 to 5-minute) PM2.5 (e.g., optical methods supported by BAM or TEOM measurements that only provide hourly PM data. The Thermo pDR/aDR1500 has been shown to provide useful measurement of PM2.5 at 1-minute or less time resolution:
http://www.thermoscientific.com/ecomm/servlet/productsdetail_11152_L11082_89583_11961321_-1
NO and NO2 (1 to 5-minute resolution)

The EcoTech PAH analyzer provides qualitative highly time-resolved measurement of particle-bound PAH. While data quality is not high, the method is inexpensive and easy to run.
http://www.ecochem.biz/PAH/PAS2000.htm

Canister measurements of VOCs, both routine (every x days) and possibly event-triggered samples driven by the TNMHC real-time measurements. Similar event grab samples could be taken using the SO2/TS real-time measurements.

The less intensive fixed sites could include passive measurements of VOC, SO2, and possibly NH3; the two major suppliers of passive samplers and related chemistry are noted in the DRI report. PM2.5 could be measured using optical scattering methods such as the self-contained Thermo aDR-1500. Electro-chemical sensors are available for many gases, including CO, H2S, chlorine, ClO2, mercaptans, HCl and others; this technology has dramatically improved over the last decade, with improvements in baseline/temperature drift. One leading manufacturer of high quality electro-chemical cells is City Technology in England:
http://www.citytech.com/

Q 3: How should the data be provided to the public

A web site should be used to provide data to the public. There are several key components of a web site for this purpose:

1. A layered approach to data and interpretation that allows the user to "drill down" to the desired level of detail. The top layer would be simple, non-technical information, using messaging similar to the AQI (colors and descriptors) and indicate if conditions are normal or not. The second layer could include more pollutant-specific information (including health effects). The third layer would provide access to current and historical data and more detailed information on health effects, both chronic and acute. All layers should present information in a spatial context. For example, clicking on a site on a map leads you to the next layer of data.

2. It is critical that data from refinery network monitors be put in context with similar data from urban-scale contemporary measurements, since source-profiles from refineries under normal operating conditions are usually similar to ubiquitous mobile-source air toxics such as benzene. This would require measurements of key real-time pollutants at an urban site not influenced by refinery emissions. Data for all layers of the web site could be presented as "excess" over urban background, either alone or (for the third layer) with the actual concentrations from near-refinery and urban background monitoring sites. This is a health "risk communication" issue, acknowledging that there is some risk even during normal conditions and at urban background concentrations.

3. Data must be "time-relevant". For routine measurements (and non-event conditions), hourly data is sufficient. But during an event, data must be updated at least every 5-minutes, and ideally every minute

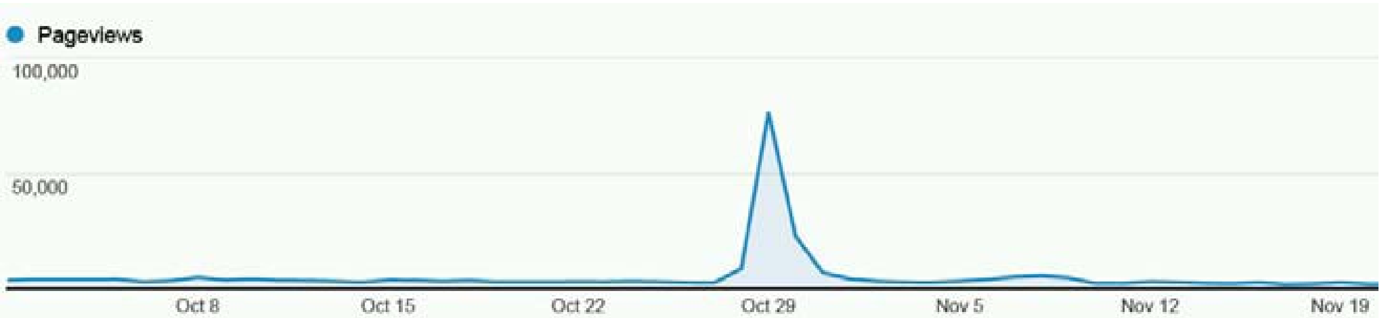
when levels are elevated. While instrument uncertainty (LOD, noise, etc) decreases at very short time intervals, the periods when high-time resolution is needed would be when high concentrations of pollution are present. Some degradation in data quality is an acceptable trade-off for high time resolution during these event conditions.

4. “Missing” data must be addressed in a transparent manner. Why it is missing (specific information, not just “invalid data” and (for real-time data) when it is expected to be available again is key information that must be provided.

5. Data quality indicators should be included in some manner at all levels of the web site. For transparency, data below LOD should be shown with suitable data quality indicators. Colors or text size, etc. could be used to mark data of inadequate quality, with the reason noted.

6. To the extent possible, web pages should be ADA-compliant, or an ADA-compliant version of the web site should be provided even if it has limited information relative to the main site. The web site should be designed to be easy to view for those with some vision impairment. This means NO low-contrast layout [e.g., no light blue on darker blue] - information should be black on white wherever possible. Users should be instructed on how to enlarge the page in the browser (View/zoom, or Ctrl +, -, and 0).

7. The web server must be capable of handling very large traffic that would likely occur during a substantial event – when the site is most needed. Below is an example of traffic to hazecam.net when superstorm Sandy hit the NY/NJ coast on Oct. 29, 2012; this demonstrates the relative traffic during an event of note.



8. Web access can not be assumed. A telephone (toll free?) hotline should be part of the data access system. Information on the hotline would be limited, similar to level 1 of the web site, and presumably limited to a single location unless all locations are “normal”. Users could enter a zip code or other geographical locator information such as the name/town of the refinery of interest when conditions are not normal. A telephone contact number for additional information during times when conditions are not normal should also be provided.

Q 4: What should be considered when developing measurement quality objectives, such as:

– What type of instrument siting criteria should be used
This is covered under the first charge question.

– What should the time resolution of the equipment be

This is covered under the second charge question.

– How often should the instrumentation be calibrated
For methods that the US EPA has established QC guidelines for, those guidelines should be followed. For other methods, good laboratory practice should be followed, taking into consideration the level of data quality needed and the stability of the method.

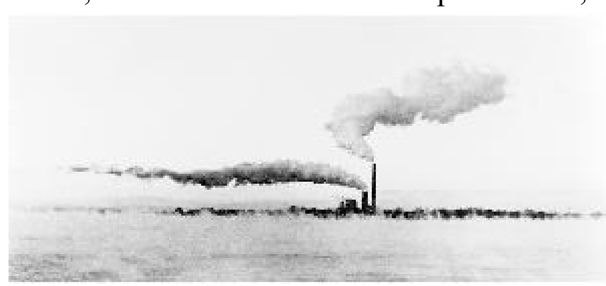
– What should the accuracy/precision/completeness requirements of the data be
Accuracy and precision are most important when normal (non-event) conditions are present and hourly data and data "higher than urban background" are the primary products. As noted above, precision is less important when elevated levels are present and a trade-off between precision and high time-resolution is needed. Completeness is the most important requirement. Routine measurements normally have minimal missing data beyond precision/calibration/maintenance outages. Some methods such as open-path instruments may have substantial missing data due to the complexity of the method. If high data capture is important for these methods, appropriate resources must be made available.

– What other quality control/quality assurance requirements should be put in place
To the extent possible, "buddy-system" checks may provide useful data quality information during routine (non-event) monitoring.

Q 5: What technologies, methodologies and tools could be employed to augment any fixed network to better quantify pollutant variations over space and time, especially during short duration incidents

Rapid deployment of mobile measurements are critical to provide detail on areas of maximum concentrations. The mobile platform must have very highly time-resolved measurements of key indicator pollutants – one minute or less if possible. In addition to methods noted above, portable photo-ionization detectors (PID) instruments may provide useful data for mobile use.

Real-time dispersion modeling along with the real-time fixed monitors could be used to determine the most likely area[s] of maximum concentrations. To maximize the accuracy of the dispersion modeling, wind data at multiple levels at or just down-wind of the refinery are needed, from 10 meters to stack-top elevation, including 30 and possibly 100 meter wind. Multiple elevations are essential since wind direction can change dramatically over several hundred feet as shown in this classic picture by Bruce Egan of the Salem (MA) Harbor coal-fired EGU. The coastal meteorology present at these refineries further complicates estimation of plume impacts using dispersion modeling. These wind measurements should be "3D" sensors that include the vertical wind component. Wind data must be highly time-resolved – 1 minute or less, with vector averaging up to longer time-scales (e.g., 5, 10, 15 minutes or more).



Another source of surface wind data that may be useful during an event is the dense "network" of personal weather stations (PWS) that report to organizations such as the Citizen's Weather Observing Program (CWOP). These data go into the NOAA Meteorological Assimilation and Data Ingestion System (MADIS)

where they are QC's using a "buddy-system" approach. The data and related QC parameters are "exposed" by CWOP. See a presentation I gave at the 2009 EPA national monitoring conference:
http://www.epa.gov/ttn/amtic/files/2009conference/AllenFreeMetQC.pdf

Some PWS only report to weather underground and do not receive MADIS QC; all CWOP sites appear on weather underground, identified as APRSWXNET for the data source and with site IDs consisting of M and a single letter ©, D, or E) followed by four digits. Example: MD2257. A list of public stations sending data into MADIS from many different mesonets (CWOP is one of many) is at:
http://madis.noaa.gov/public_stntbl.csv
Weather underground provides maps of station locations that link directly to a station's data:
http://www.wunderground.com/wundermap/?lat=37.94056&lon=-122.34944&zoom=12
Data are also available from the MesoWest database:
http://raws.wrh.noaa.gov/cgi-bin/roman/meso_base.cgi?stn=D2257&unit=0&time=LOCAL

Another "measurement" that may be useful is automated photography. Properly sited high resolution cameras (not "web-cams") could be used to track and document plume location, dispersion, and elevation during an event (the pictures from the August 2012 event demonstrate the value of this approach). These cameras could be both visual and infra-red (for night-time use). Ideally each refinery would have three cameras providing views from a few miles away from three angles of view to allow triangulation of any visible plume. A camera network could be part of the web-site (a valuable outreach tool), and could capture smaller events that may not be picked up by the routine monitoring network. A network of "visibility" cameras I run in the northeast US has captured several notable pollution events (including the direction and intensity of the 9/11 NYC plume), and has been used as part of an enforcement action against an EGU in the Boston area by the US EPA. See: www.hazecam.net . Mexico City has a "hazecam" looking at Popocatepétl:
http://148.243.232.113:8080/calidadaire/vigilancia_cam/hazecams.php

Q 6: What emerging technologies might be utilized in the future to further enhance community air monitoring capabilities

There are some key pollutants that are difficult to measure, such as carbonyls, especially HCHO and acetaldehyde. At present, even routine integrated measurement of these carbonyls (using DNPH cartridges) is difficult; optical (open path) methods are the only reliable technique. Carbonyl source profiles may be very different than the more common MSAT-related pollutants, making them important pollutants to measure. There is at least one promising technology under development. Thermo has their "IRIS" system that uses mid-IR spectroscopy to measure methane, CO, CO2, and N2O. As this technology matures, wavelengths are expected to get into the UV range. Conversations with Thermo R&D staff have indicated that measurement of HCHO and other toxic VOCs with high time-resolution should be possible with this technology with the next several years. Information on the IRIS method is at:
http://www.thermoscientific.com/ecomm/servlet/productscatalog_11152__89577_-1_4

The US EPA/ORD has a new program to identify and characterize "next-generation air monitoring" (NGAM) technologies that are in the development stage. Presentations from a meeting earlier this year are at:
http://sites.google.com/site/airsensors2013/final-materials

Another site related to EPA's NGAM efforts but run by Sonoma Technology is:
http://citizenair.net/

Next Steps –

Air District staff will be utilizing the input from the Panel to develop guidance for air monitoring at and near refineries as part of the proposed Petroleum Refining Emissions Tracking rule, and to develop appropriate supplemental monitoring conducted by the Air District (e.g., mobile monitoring during incidents). Additional Expert Panels may be assembled to provide additional input on other topics associated with emissions from refineries to ensure that the best and most effective tools are employed to assess impacts from these sources. Lessons learned during this process may be incorporated in the future.